APPENDIX 3-3

WATER QUALITY MODEL DOCUMENTATION MEMORANDUM

BLACK & VEATCH.

TECHNICAL MEMORANDUM

South Florida Water Management District
EAA Reservoir A-1
Work Order No. 5

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Task 5.3.2.5 Water Quality Model Documentation Memo
Water Quality Model

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From: Andy Andrews

1. OBJECTIVE

Task 5.3.2.5, Model Documentation Memorandum, of Work Order 5, requires Black & Veatch to prepare a memorandum that describes the DMSTA2 model, input and output data files and parameters, and model documentation and user's manual. This is information the District would need to be able to utilize the model in the future.

The objective of this memorandum is to document the DMSTA2 model as required in Task 5.3.2.5.

2. DMSTA FOR RESERVOIRS

2.1 Description

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was developed by Dr. Bill Walker and Dr. Bob Kadlec under contract with the US Department of Interior and the US Army Corps of Engineers to support the design of wetland treatment areas that would be capable of removing phosphorus from stormwater runoff from the Everglades Agricultural Area and Lake Okeechobee releases.

Compared with typical marsh treatment areas in the STAs, CERP storage reservoir designs, such as the EAA A-1 Reservoir, tend to have greater mean depths, greater variations in depth, and longer water residence times. These factors can be expected to have significant effects on vegetation communities, phosphorus dynamics, and model calibrations. Currently, STAs are operated at a static water depth of 1.2 to 1.5 ft. Deteriorations in vegetation integrity and performance have been observed in cells with prolonged water depths exceeding 2.5 to 3 ft. Current designs for CERP reservoirs have maximum depths ranging from 6 to 12 ft. The expected maximum operating depth for the A-1 Reservoir is about 12 ft.

DMSTA2 was calibrated and tested using existing datasets for the following Florida lakes:

- Okeechobee
- Istokpoga
- Jessup
- Crescent
- Thonotosassa
- George
- Rodman
- Harney
- St. Johns Marsh
- Sawgrass
- Hell Blazes

DMSTA Version 2 (DMSTA2), which was first released in June 2005, was enhanced to support its application to deeper storage reservoirs. Model documentation and user information is available at: http://www.wwwalker.net/dmsta/index.htm. The current version of the program, dmsta2.xls, is available for downloading at the above website.

2.2 Application DMSTA2 to the A-1 Reservoir

Application of DMSTA2 to the A-1 Reservoir involved the following steps:

- Time series of inflows and outflows to the A-1 Reservoir were imported from the ECP 2010 model (Appendix 5-21), which were also used in the B&V Water Balance

Model (WBM). Inflows included available flows from the New North River Canal (NNR) at Pump Station 370; available flows from the Miami Canal (MC) at Pump Station 372; and rainfall. Outflows included releases to agricultural areas and conservation areas and evapotranspiration.

- Time series of phosphorus concentrations associated with the NNR and the MC were based on monthly average concentrations developed by Burns & McDonnell (B&M) as part of the Regional Feasibility Study, Task 1.3, Historical Inflow Volumes and Total Phosphorus Concentrations by Source, June 27, 2005.
- The times series described above were imported to DMSTA2, which produced continuous daily simulations of water and phosphorus mass balances over a long-term simulation period. The time series for each of the nine cases investigated for this study are provided in Appendix 3-4 as electronic files.

3. DMSTA2 INPUTS AND OUTPUTS

3.1 Area and Volume

Inputs to DMSTA2 that describe the area and volume of the A-1 Reservoir are in terms of surface area and outflow weir depth, which was set at 365 cm (12 ft). DMSTA2 assumes that water will be released from the reservoir if the depth exceeds 12 ft (365 cm). The surface area of the reservoir was set at a constant 64 km2 (15,800 acres).

3.2 Canal Flows

Water stored in the A-1 Reservoir will be supplied from the NNR and MC. The ECP 2010 model (Appendix 5-21) provided times series of average daily flows for each of these sources for a 36 years simulation period from 1965 to 2000. These time series were inputs to DMSTA2. The time series of canal flows for each of the nine cases investigated for this study are provided in Appendix 3-4 as electronic files.

Phosphorus concentrations associated with flows in the NNR and MC were based on monthly average concentrations developed by the previously cited B&M Regional Feasibility Study.

3.3 A-1 Reservoir Demands

The A-1 reservoir will store water that will be released to meet irrigation and conservation demands. The ECP 2010 model (Appendix 5-21) provided times series of average daily flows for each of these demands for the 36 years simulation period. These time series were input to DMSTA2. The time series of irrigation and conservation demands for each of the nine cases investigated for this study are provided in Appendix 3-4 as electronic files.

3.4 Rainfall and Evapotranspiration

Rainfall and evapotranspiration data were obtained from the ECP 2010 model (Appendix 5-21) and input to DMSTA2. The time series of rainfall and evapotranspiration data for each of the nine cases investigated for this study are provided in Appendix 3-4 as electronic files.

3.5 Seepage

DMSTA2 calculates seepage outflow from the reservoir based on a user defined rate in cm per day per cm of reservoir depth. As the reservoir depth increases so does the rate of seepage. DMSTA2 also allows a user to define potential seepage re-cycling back to the reservoir as a fraction of the predicted seepage outflow.

Using hydrologic and hydraulic models, B&V predicted seepage rates for several depths of seepage cut-off walls. The seepage outflow rate and return fraction in DMSTA2 was based on the B&V seepage and return rates for a 34 ft cut-off wall and a seepage collection canal with a bottom elevation 10 ft below the bottom of the reservoir.

3.6 Operation of DMSTA2

Program operation is controlled from the Menu Screen. This screen contains four list boxes for selecting the project input file, design case, simulation type, and model output screen. The menu screen is can be viewed at http://www.wwwalker.net/dmsta/index.htm

Addition input variables are defined by the user on the Parameter Screen, which can also be viewed at above website. All input variables, including the times series, e.g. average daily releases from the A-1 Reservoir to meet agricultural demands, are also included in the Project File. Revisions to the times series are made in the Project File. The Project File for this study, which includes the input time series for each of the nine cases investigated, is include as an electronic attachment in Appendix 3-4.

3.7 Input and Output Data Screens

In addition to the previously discussed Menu and Parameter Screens, DMSTA2 also provides numerous screens for summarizing and viewing the output data. Included are screens that summarize water and phosphorus mass balances over the simulation period and numerous graphs of model results, such as reservoir depth and outflow phosphorus concentration. Table 3.7-1 is a list of the DMSTA2 input and output screens. The "Link" in the table provides an example (not related to this project) of each screen.

3.8 Model Results

The following eight cases were investigated with DMSTA2 for this study:

- **Case 1A_1**: Reservoir with example time series of inflows and releases; constant P inflow of 100 ppb
- **Case 1A_2**: Reservoir with example time series of inflows and releases, but with varying P inflow concentrations based regression equation
- **Case 1A_3**: Times series based on B&V Water Balance Model (WBM) Version 1; constant P inflow of 100 ppb
- **Case 1A_4**: Time series based on WBM Version 1; outflow weir increased from 300 cm to 365 cm; constant P inflow of 100 ppb
- **Case 1A_5**: Time series based on WBM Version 2

- **Case 1A_6**: Time series based on WBM Version 3
- **Case 1A_7**: Time series based on WBM Version 3, B&M Variable P inflow concentrations
- **Case 1A_8**: Time series based on WBM Version 4, B&M Variable P concentrations.
- **Case 1A_9**: Time series based on WBM Version 5, B&M Variable P concentrations. This case presents the final results.

The results of each of the nine cases are provided as executable electronic files in Appendix 3-4.

TABLES

Table 1 DMSTA2 input and output screens

(click CTRL + Mouse Click on the red bullet to make the link live)		
Link	**Screen Name**	**Description**
	Menu	Program Menu
	Series_Input	Time Series Input Sheet
	Parameters	Parameter Input Sheet
	Network	Network Input / Output Sheet
	MassBal_Overall	Overall Mass Balance Table
	MassBal_Cell	Cell Mass Balance Tables
	Reservoir	Reservoir Simulation Output
	Schematic	Water & Mass Balance Schematic
	FreqDist	Frequency Distributions
	Ranges	Comparison of Cell Properties with Calibration Ranges
	Graphs_Overall	Time Series Charts - Overall
	Graphs_Cell	Time Series Charts - By Cell
	Graphs_Any	Time Series Chart for User-Selected Variables & Cells
	Graphs_Summary	Comparison of Cell Mean Values
	Cases	Summary of Results for Each Case in Current Project